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Status of CERES/SSF EOS/MODIS and NOAA-KLM/AVHRR3 Aerosol Products over ocean

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NEW DEVELOPMENTS

- **Two aerosol products over ocean on *Terra/Aqua* CERES SSF datasets *(JAS CLAMS Special Issue, submitted, NESDIS/LaRC/GSFC)***

- **Operational Aerosol Observations from AVHRR/3 onboard NOAA-KLM *(JTech, in press, NESDIS)***

- **Equator Crossing Times for NOAA, EOS and ERS Sun-synchronous satellites *(Int. J. Rem. Sens., submitted, NESDIS)***

Terra/Aqua CERES SSF

EOS/MODIS

1) Terra (Dec 1999, 10:30 AM)
2) Aqua (May 2002, 01:30 PM)

CERES SSF: *Terra* (FM1/2) & *Aqua* (FM3/4)

- **Primary M-product: from MODIS aerosol group**
- **Secondary A-product: τ_1(0.63), τ_2(1.61/2.13 μm)**

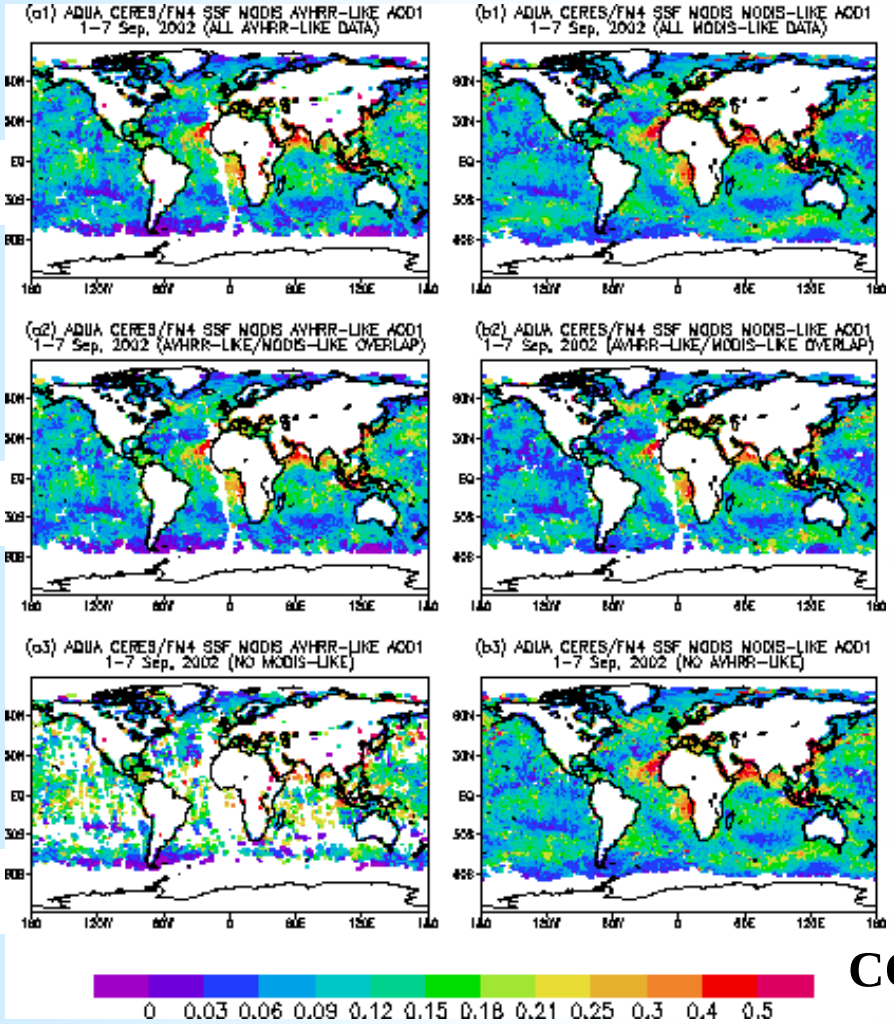
- **Two aerosol products over ocean on *Terra/Aqua* CERES SSF**
  (JAS CLAMS Special Issue, submitted, NESDIS/LaRC/GSFC)

<u>M-/A-products documented/preliminarily analyzed</u>

1) **available in different domains**
2) **where both available: compare surprisingly well!**
3) **differences due to sampling not aerosol model**
4) **both M-/A-products correlate w/ambient cloud**
5) **band 1.61 μm: truncated; inoperative on *Aqua*: Use 2.13 μm**

Aqua τ_1@0.659 μm: 1-7 Sep 2002

A-product **M-product**



A_T~43%

A_T~53%

ALL DATA

A_T~42%

A_T~42%

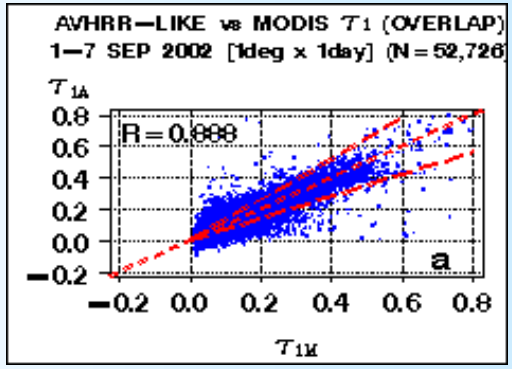
OVERLAP

A_T~48%

A_T~59%

COMPLEMENT

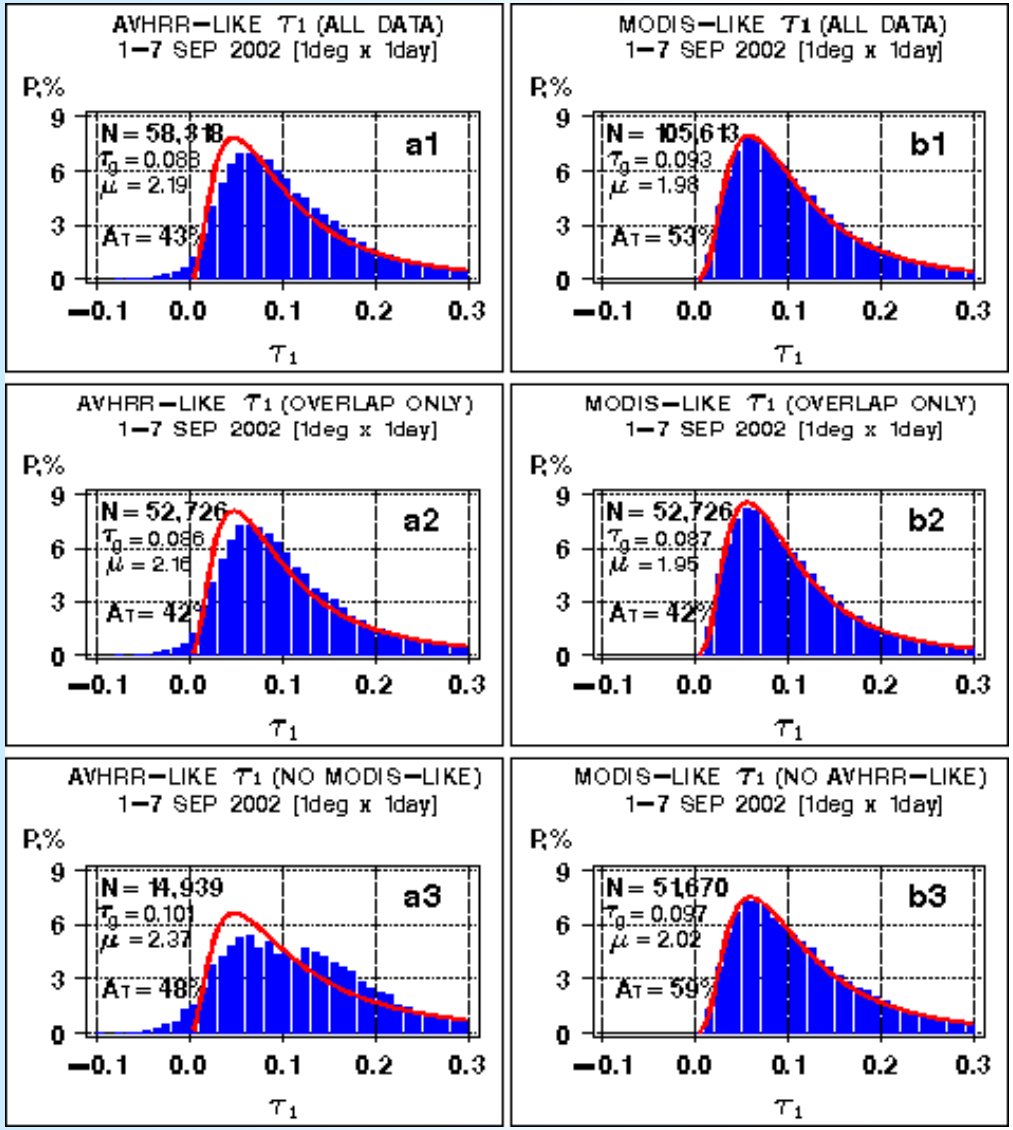
- **Data good**
- **Patterns similar**
- **τ coherent with cloud, A_T**



- **τ_M & τ_A: Correlated**
- **Scatter at low τ: Aerosol model unlikely**

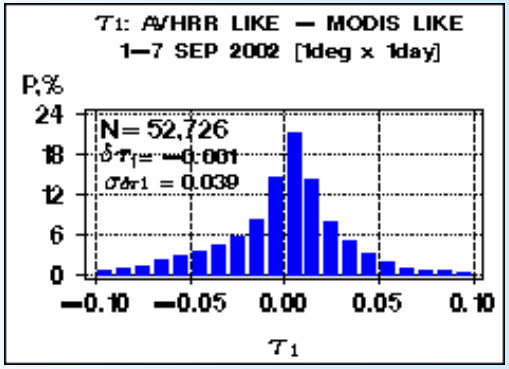
Aqua τ_1@0.659 μm: 1-7 Sep 2002

A-product **M-product**



- τ_M closer to LN than τ_A
- $\sigma_{\tau M}<\sigma_{\tau A}$
- No data with $\tau_M<0$
- ~2% of data: $\tau_A<0$

ALL DATA



OVERLAP

- τ_A-τ_M: bias~-10^{-3}; σ_τ~0.04

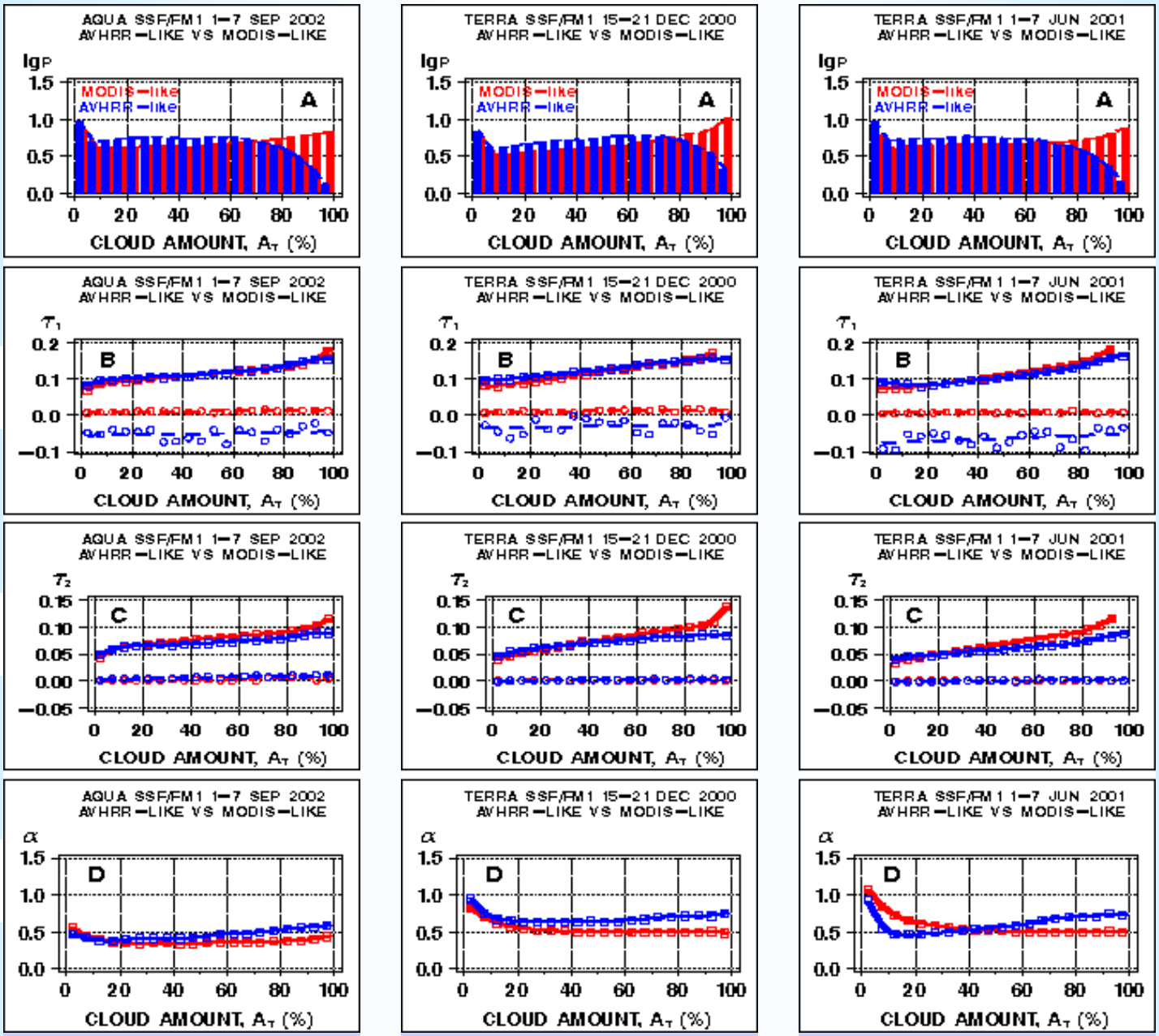
COMPLEMENT

MODIS Aerosol/Cloud Correlation

τ_1 (0.659 μm)

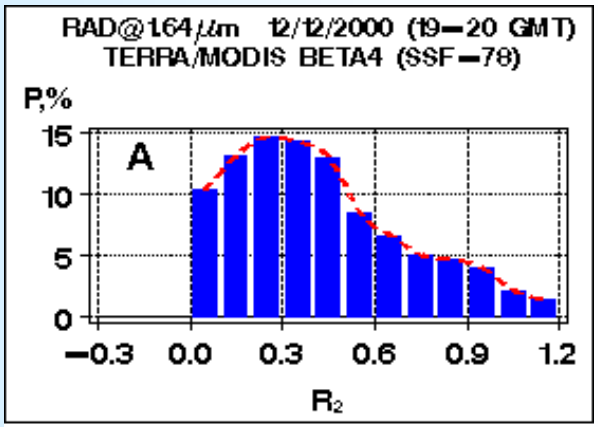
τ_2 (1.640 μm)

α

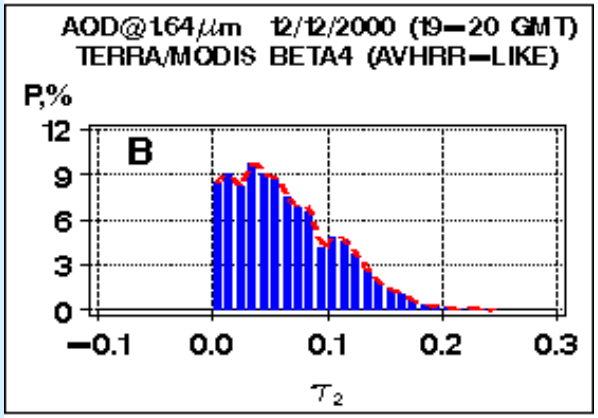


Aqua Sep 2002 | *Terra Dec 2000* | *Terra Jun 2001*

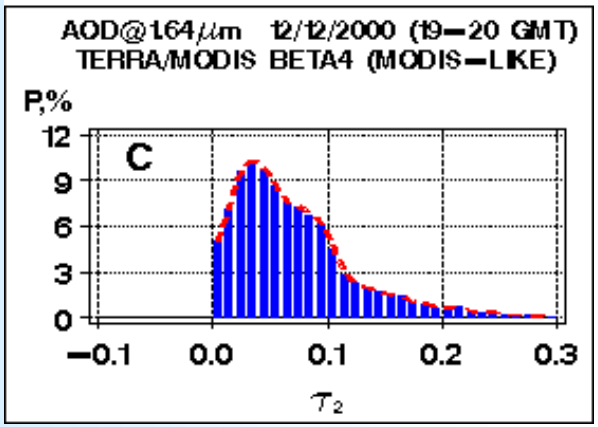
Truncation @1.61 μm



AEROSOL RADIANCE



AVHRR-like AOD



MODIS AOD

SUMMARY TO MODIS

τ/α-Retrievals:

- **Primary M-product: (τ, α) more self-consistent**
- **Secondary A-product: Insight into channel's performance**
- **M-/A-products: much similarity**
- **Correlation: τ_1 (R~0.8-0.9), τ_2 (R~0.6-0.8), α (R~0.4-0.7)**
- **Differences: mainly due to sampling (As/more important as aerosol algorithm)**
- **Ambient cloud amount: Key parameter in both products**

ISSUES/PLANS

1) **Sampling vs. Algorithm**
2) **Cloud/Aerosol Correlations**
3) **Truncation of negative radiances @ 1.640 μm**
4) **Document/QC/QA TRMM VIRS aerosol product**

NOAA-KLM AVHRR/3

1) NOAA-16 (L) (SEP 2000, 02:00 PM)
2) NOAA-17 (M) (JUN 2002, 10:00 AM)

- **AEROBS Operational/PATMOS Plans**
- **A-product: single-channel $\tau_1(0.63)$, $\tau_2(0.83)$, $\tau_3(1.61\ \mu m)$**

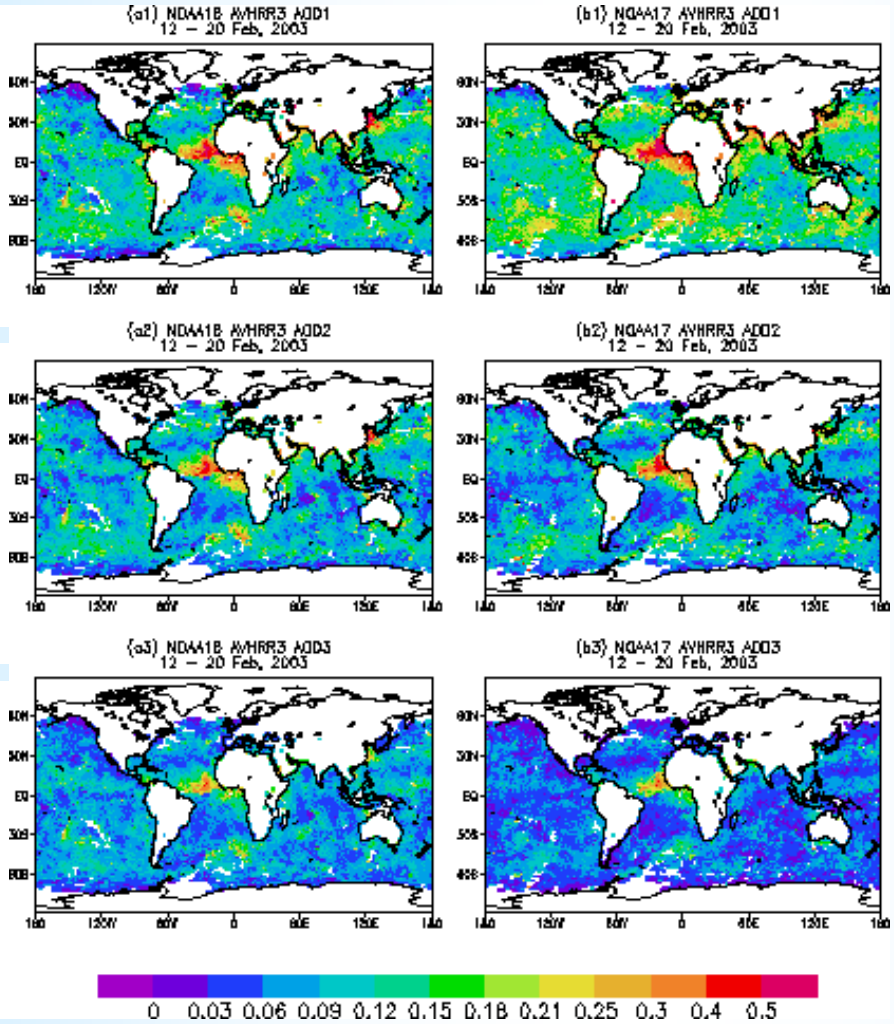
- **Operational Aerosol Observations from AVHRR3 onboard NOAA-KLM Satellites** ***(JTECH, in press)***
  1) **NESDIS 3rd gen (KLM/AVHRR3) algorithm documented**
  2) **AVHRR3 (0.63/0.83/1.61 μm): Independent channel solution**
  3) **NOAA-16/afternoon & NOAA-17/mid-morning platforms**
  4) **Fully comparable to MODIS/VIRS A-products**

NOAA-KLM AVHRR/3 Aerosols 12-20 February 2003

τ_1 (0.63 μm)
R_1=0.82
$\delta\tau_1$~+0.03
$\sigma_{\tau 1}$~0.05

τ_2 (0.83 μm)
R_2=0.80
$\delta\tau_2$~-0.01
$\sigma_{\tau 2}$~0.04

τ_3 (1.61 μm)
R_3=0.74
$\delta\tau_3$~-0.02
$\sigma_{\tau 3}$~0.03



- Patterns similar
- Correlation R high
- R decreases with λ
- Biases opposite in channels (calibration)
- σ_τ decreases with λ

NOAA-16 (2 PM) *NOAA-17 (10 AM)*

SUMMARY TO AVHRR

τ -Retrievals:

- **NOAA-KLM/AVHRR3 3rd gen aerosol up & running**
- **Good to monitor: (1) aerosol; (2) AVHRR performance**

http://www.osdpd.noaa.gov/PSB/EPS/Aerosol/Aerosol.html
http://www.saa.noaa.gov/

- **AVHRR cal major issue**
- **Care advised in quantitative use**

PLANS

1) **PATMOS processing/Cal adjusted**
2) **Self-/Inter-consistency of NOAA-16/-17**
3) **Merge with Terra/Aqua MODIS for cross-checks**

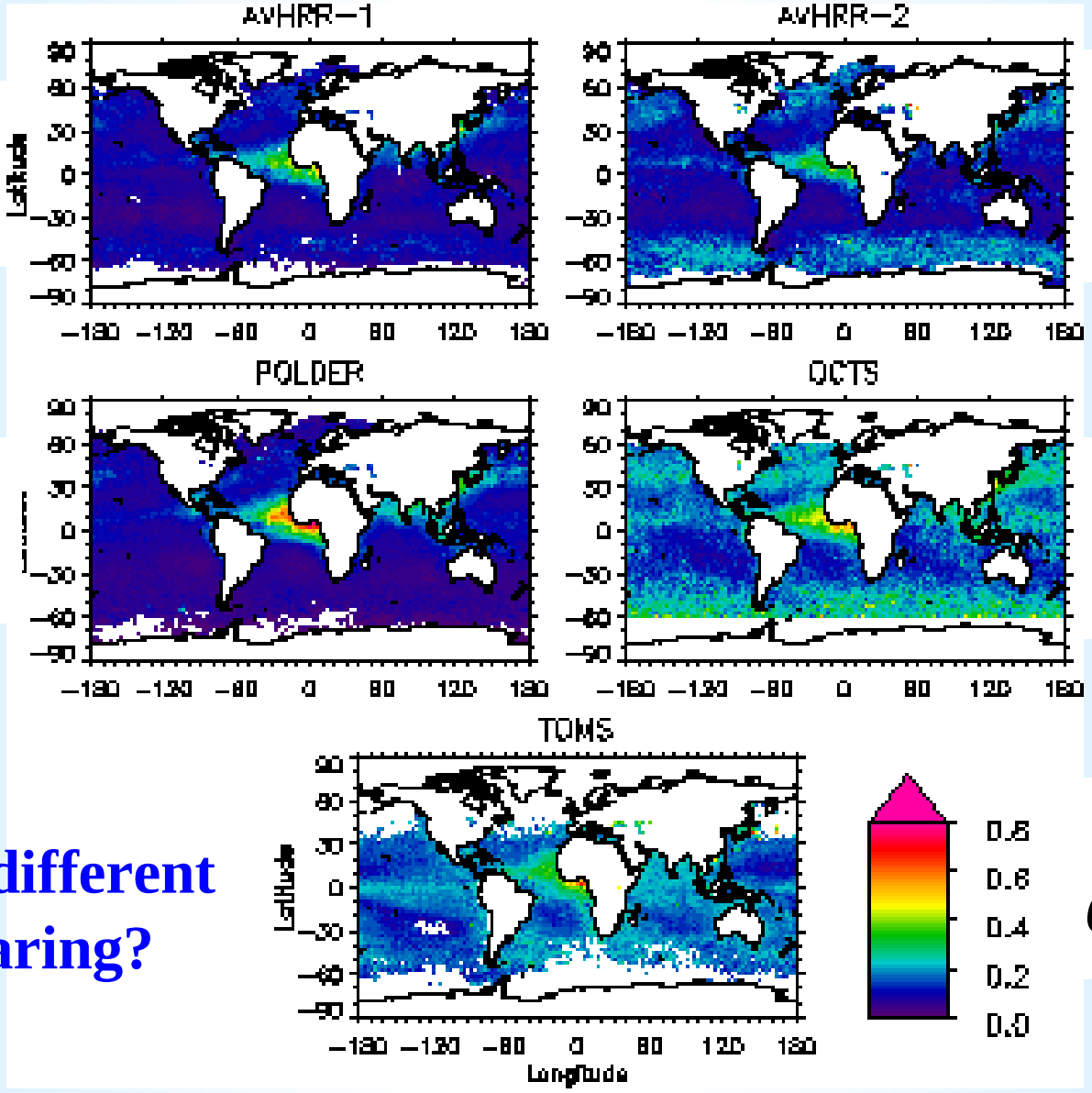
8-month average AOD@0.55 μm: Nov 1996 - Jun 1997

NOAA14/AVHRR PATMOS (Stowe et al. 1997)

NOAA14/AVHRR ISCCP/GACP (Mishchenko et al. 1999)

ADEOS/POLDER (Goloub et al. 1999, Deuze et al. 2000)

ADEOS/OCTS (Higurashi and Nakajima 1999)



??/TOMS (Torres et al. 2002)

- **Products different**
- **Cloud clearing?**

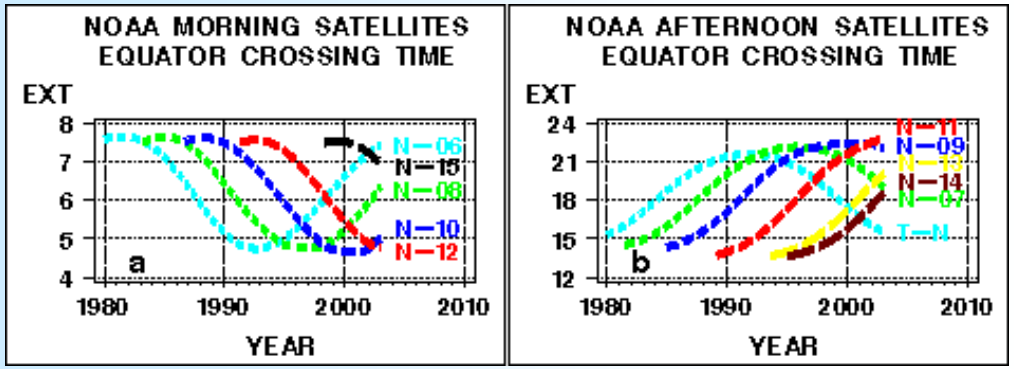
ORBITAL "DEGRADATION"

- **Equator Crossing Time for NOAA/ERS/EOS Sun-synchronous satellites**

  1) Vis/Near-IR: illumination; thermal IR: diurnal cycle
  2) Consistency important for climate
  3) Analyzed all NOAA platforms, EOS, ERS
  4) fit NOAA: past EXT (within ½ min); future prediction

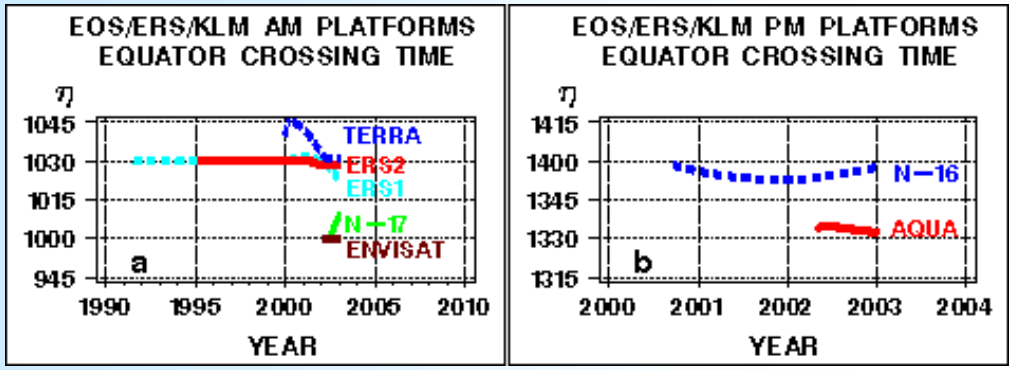
EQUATOR CROSSING TIME

NOAA PLATFORMS



- **NOAA: Natural Evolution (One-two harmonics)**
- **Afternoon NOAA platforms**
- **T~28-35 yrs; A~3.5-5.0 hrs**
- **Morning NOAA platforms**
- **T~23 yrs; A~1.4-1.5 hrs**

EOS & ERS PLATFORMS



- **EOS: Stable within minutes**
- **ERS: Stable within seconds**

Should be taken into account in climate analyses

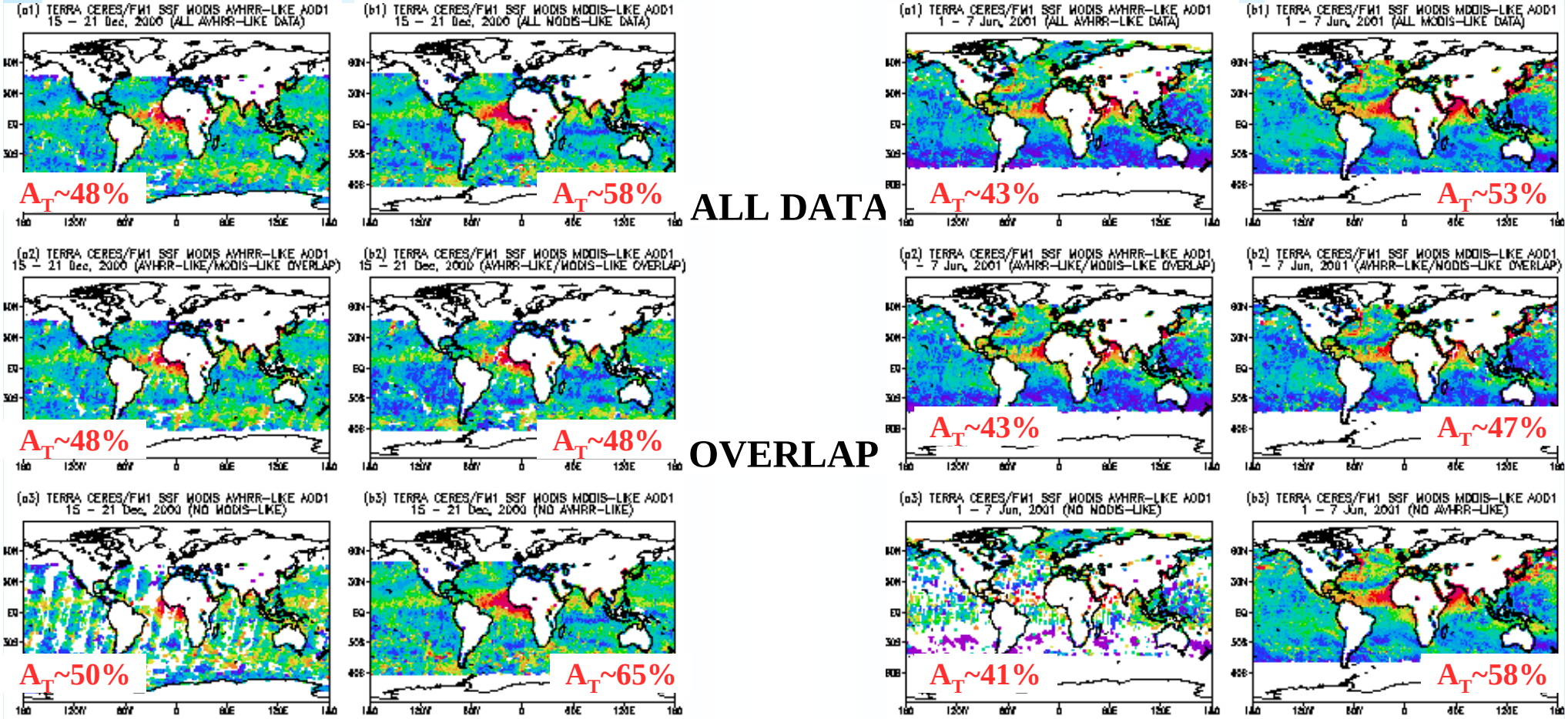
BACK-UP

Terra τ_1@0.659 μm

15-21 Dec 2000

1-7 Jun 2001

AVHRR-like | **MODIS-like** | **AVHRR-like** | **MODIS-like**



ALL DATA

OVERLAP

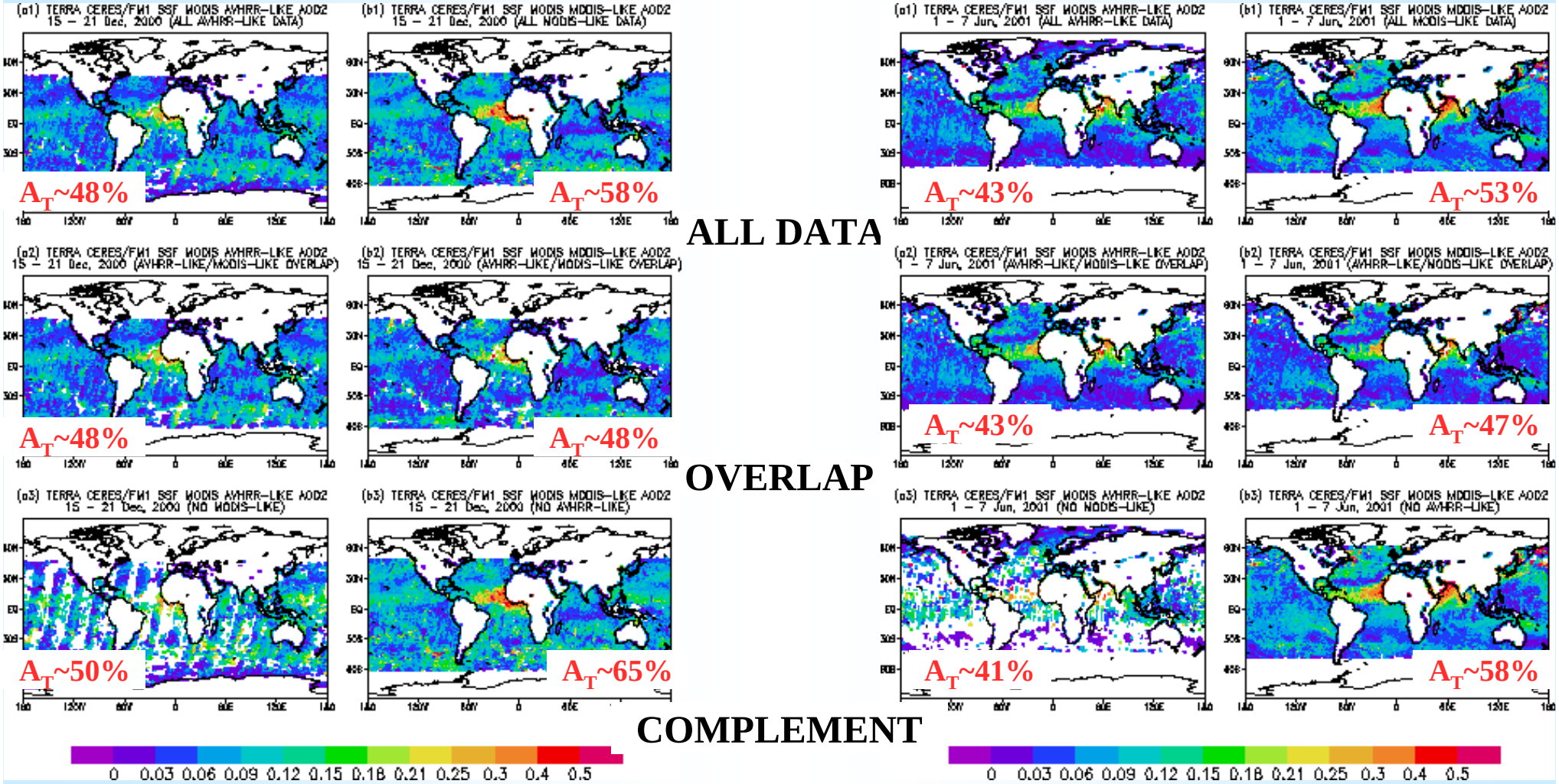
COMPLEMENT

Terra τ_2@1.640 μm

15-21 Dec 2000

1-7 Jun 2001

AVHRR-like | **MODIS-like** | **AVHRR-like** | **MODIS-like**

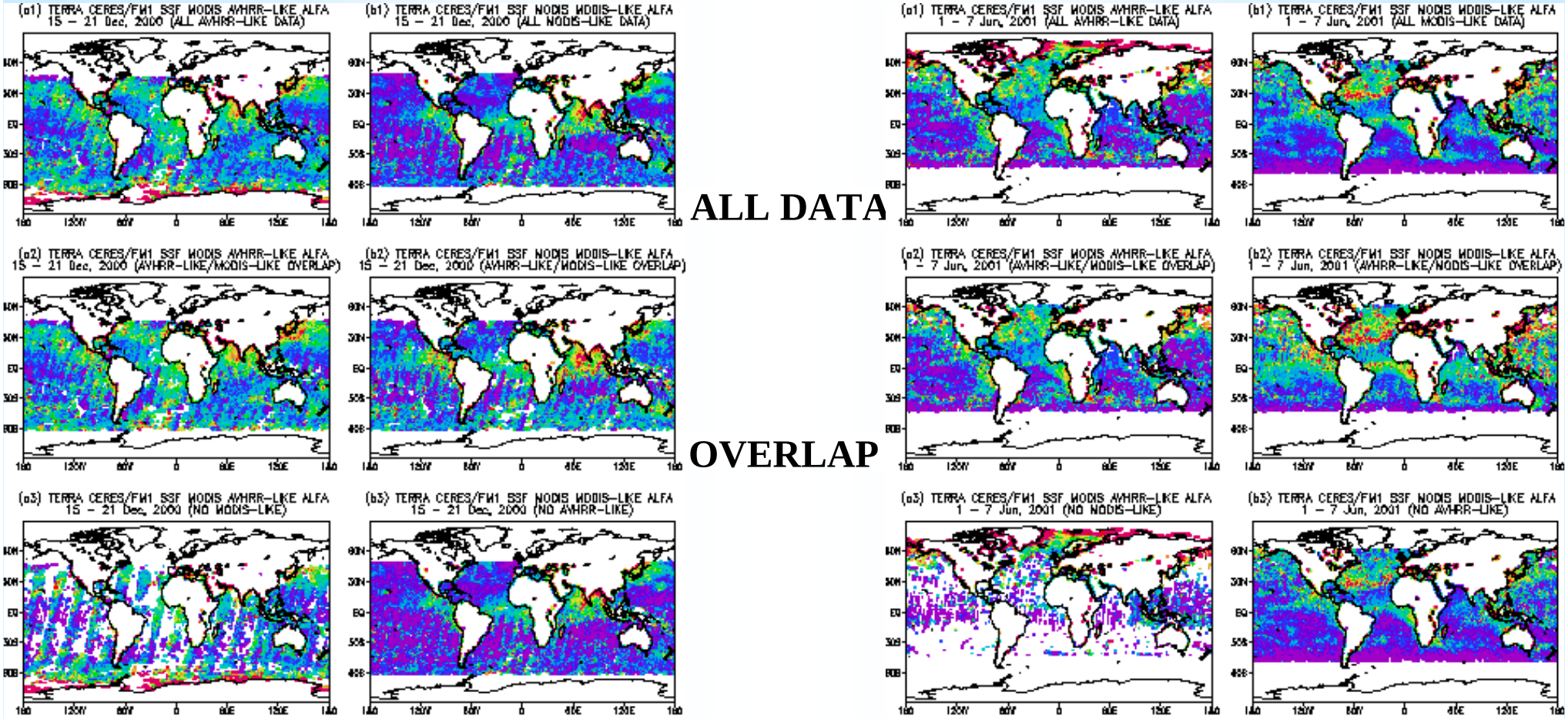


Terra α (0.659/1.640 μm)

15-21 Dec 2000

1-7 Jun 2001

AVHRR-like **MODIS-like** **AVHRR-like** **MODIS-like**



OUTSTANDING ISSUES

Cloud/Aerosol Correlation

- understand physics (residual cloud in the FOV vs. cloud/aerosol interaction)
- new strategies of cloud clearing: continuum aerosol-cloud

Data Quality (Sampling/Cal/Truncation)

- important for aerosol product
- more science in decision making
- unification/standartization

Cloud Screening

M-product (Martins et al.): Done by MODIS Team

A-product (Minnis et al): Consistent w/ TRMM/VIRS

Glint Screening

M-product: Beyond 40° glint

A-product: Beyond 40° glint & Anti-solar side of Orbit

Aerosol Algorithm

M-product (Tanre et al. 1997)

- **Spectral:** 6 bands from 0.55-2.13 μm
- **Aerosol:** Var Bi-LogNormal (Mode Location/Ratio)
- **Surface:** Fresnel (V=7 m/s) + Black (except 0.55 μm)
- **RT Model:** Ahmad-Fraser (JAS 1981)

A-product (Ignatov Stowe 2002; Ignatov et al. 2003)

- **Spectral:** Single-Channel: 0.659 & 1.640 μm
- **Aerosol:** Prescribed (Fixed) Mono-LogNormal
- **Surface:** Fresnel (V=1 m/s) + Small Diff.Ref.
- **RT Model:** Vermote et al. 6S (IEEE/TGARS 1997)